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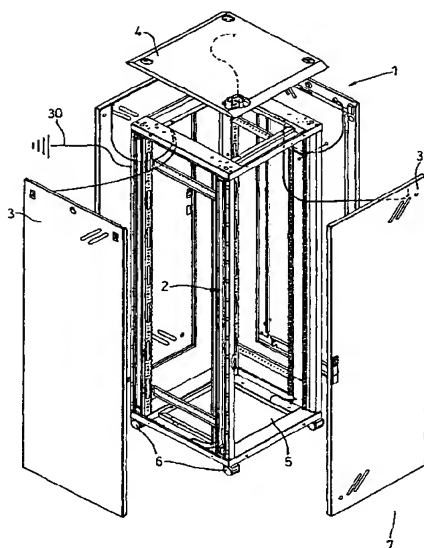
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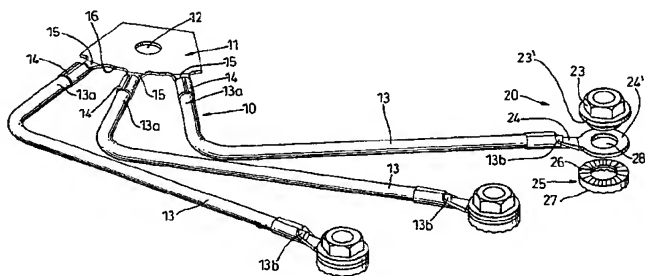
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[Continued on next page]

(54) Title: ELECTRICAL CONDUCTIVITY CONNECTORS



(57) Abstract: An electrical conductivity connector comprises a conductive plate (11) for connection to a metal enclosure (1) of multi-panel (3, 4) form, a plurality of leads (13), each lead being permanently secured at one end (13a) thereof to the conductive member, the opposite end (13b) of each lead carrying a captive nut assembly (20) for electrically connecting the conductive member (11) to a respective panel (3, 4) or frame member of the enclosure. Each captive nut assembly (20) comprises a nut (23) provided with an integral axial extension (29) of reduced lateral dimensions compared with the diameter of the nut, the axial extension extending through a hole (28) in a connector tag (24') and being captively connected at the free end thereof to a washer (25) positioned on the opposite side of the tag from the nut.



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## ELECTRICAL CONDUCTIVITY CONNECTORS

This invention relates to electrical conductivity connectors and has particular, but not exclusive, application to metal enclosures for housing electrical or electronic equipment, of the form comprising a skeleton  
5 frame structure with a plurality of panels secured thereto. Such enclosures, often called 'racks', may be adapted to be wall-mounted, or may be free-standing.

According to one aspect of the present invention, an electrical conductivity connector comprises a conductive member for connection to  
10 a metal enclosure of multi-panel form, a plurality of leads, each lead being permanently secured at one end thereof to the conductive member, and each lead being provided at the opposite end thereof with respective attachment means for electrically connecting the conductive member to a respective panel or frame member of the enclosure, the attachment means  
15 each carrying a respective captive fastener.

Such conductivity connectors allow conductivity to be established throughout the metal enclosure.

The conductive member is preferably of planar form, with a fixing hole, enabling the conductive member to be fixed to the enclosure frame, (or  
20 other suitable part of the structure), by use of a screw, or onto a stud.

The respective first ends of the leads are preferably secured to the periphery of the conductive member, which is preferably provided with laterally spaced-apart pairs of integral clamping jaws.

Although the captive fastener could be a screw, preferably the fastener is  
25 a nut assembly.

Each captive nut assembly preferably comprises a nut provided with an integral axial extension of reduced lateral dimensions compared with the diameter of the nut, the axial extension extending through a hole in a connector tag and being captively connected at the free end thereof to a washer positioned on the opposite side of the tag from the nut.

Preferably the connection between the free end of the axial extension and the washer, and the dimensions of the axial extension, are arranged such that, on initial supply of the conductivity connector, the nut is capable of being turned freely relative to the washer and tag, to reduce the tendency of the tag from being turned round when the nut is tightened onto the tag.

The axial extension is preferably an integral tubular extension of the nut.

The free end of the axial extension is preferably deformed radially outwards to define an annular retaining rib that is received in a counterbore to the bore of the washer.

The retaining rib is preferably formed by a swaging operation which is controlled to permit rotation of the washer relative to the axial extension.

The tag preferably carries a pair of clamping jaws by which said other end of the lead is secured to the tag.

The washer is preferably provided with gripping formations at least on the side that engages with the tag.

The invention, according to a second aspect, also comprises the combination of a metal enclosure and a plurality of said electrical conductivity connectors.

The combination may be of kit form whereby the enclosure comprises a flat pack.

Alternatively the metal enclosure may be supplied to an installer as a pre-assembled unit, but without connection of the connectors that are to be  
5 secured to removable panels. (The panels are generally removed during installation of the electrical/electronic items.) Said one ends of the leads are preferably pre-assembled to the enclosure, whereby the leads are available in the unit in the correct locations, ready for said other ends of the leads to be secured to the panels once the electrical installation has  
10 been performed, and the panels are ready for assembly to the framework.

We are aware of previous proposals for captive nuts on cables, for example in patent specifications no. US 5842894, FR 2758910A and DE 2606043A.

According to a third aspect of the invention we provide an electrical lead  
15 carrying a captive nut assembly at one end thereof, the nut assembly comprising a nut provided with an integral axial extension of reduced lateral dimensions compared with the diameter of the nut, the axial extension extending through a hole in a connector tag and being captively connected at the free end thereof to a washer positioned on the opposite  
20 side of the tag from the nut.

The various aspects of the invention will now be described by way of example only, with reference to the accompanying drawings, wherein:

**Figure 1** is a view in perspective, and of exploded form, of a metal enclosure for housing electronic components (not shown),

**Figure 2** is a view in perspective of an electrical conductivity connector for use with the enclosure of **Figure 1**; and

**Figure 3** is a view in perspective, and partly in section, of one of the lead attachment means of the connector of **Figure 2**.

- 5     The metal enclosure 1 of **Figure 1** comprises a skeleton frame structure 2 with a plurality of side 3, top 4 and bottom 5 panels releasably secured thereto.

The enclosure 1, which houses electronic (or electrical) equipment (not shown), is mounted on castors 6 so that it may be moved over a floor 7.

- 10    The enclosure is demountable, having been assembled from a kit comprising a flat pack. The panels 3, 4, 5 may be painted.

Figures 2 and 3 together illustrate an electrically conductivity connector 10 comprising one of eight used to earth or ground the enclosure 1 of **Figure 1**.

- 15    The connector 10 comprises a conductive member 11 of planar form for connection to the frame structure 2 of **Figure 1**. The conductive plate 11, which is of substantially segmental form, has a substantially central hole 12, for demountably fixing the plate to the frame structure 2, by use, for example, of a screw, or onto a stud fixed to the frame structure.
- 20    Common ends 13a of the three flexible conductivity leads 13 shown, are firmly secured, by crimping jaws 14 depending from lugs 15 formed on the perimeter 16 of the plate member 11.

The other end 13b of each conductivity lead 13 carries an individual captive nut assembly 20 whereby the lead is demountably securable to a

screw-threaded stud 21 mounted on the inner surface of an associated panel. (In this example, a side panel 3.)

The stud 21 is secured to panel 3 by welding 22 of the stud disc 21', and co-operates with a nut 23 which releasably clamps a lead crimping tag 24 disposed between the nut 23 and a captive washer 25. The washer 25, (see Figure 2), has serrated upper and lower surfaces 26, 27. The nut 23 has a serrated lower surface 23'. The lead attachment tag 24 has a fixing hole 28 in the tag ring 24' whereby the tag is received by the stud 21.

The external screw thread on the stud 21 and the co-operating internal screw thread on the nut 23 are not shown in Figure 3.

The nut 23 is formed with an integral tubular extension 29 the lower end of which has been deformed outwardly by swaging to hold captive the washer 25. Washer 25 is provided in its underside with a counterbore 32 to the main bore 33 of the washer, and the axial height of the deformed portion 31 is less than the depth of counterbore 32. The swaging of portion 31 is performed in a controlled manner such that on completion the nut, with extension 29, is capable of being turned freely relative to tag ring 24' and washer 25.

Once the nut 23 has been tightened on stud 21 to grip tag ring 24', the serrations 26, 27 on washer 25 and those on the nut lower surface 23' hold the tag ring 24' and nut 23 in a shake-proof manner.

The conductivity leads 13 may of varying length, in order to suit assembly requirements.

As an alternative to a captive nut assembly 20, a captive clamping screw may be used to demountably secure a lead 13 to an enclosure component.

When the enclosure component is a panel, an internally threaded boss could be welded to the panel to receive the screw.

For a typical enclosure, such as enclosure 1, the complexity of achieving earth continuity may be reduced from 84 to 8 components, using  
5 connectors 10 according to the present invention.

The enclosure 1 is provided with a good earth, as shown at 30 in Figure 1.

The invention also improves assembly by substantially eliminating the opportunity to wrongly assemble, or omit components.

10 Nuts 23 or equivalent components are preferably formed so that special tools are needed to mount or demount them in place.

It will be appreciated that the invention enables the preparation of the leads, the sub-assembly of the termination and the crimping of these components into a single assembly with the main attachment plate to be  
15 mechanised to reduce costs.

The integrity of the resulting assembly is also improved by practically eliminating the opportunity for the installer to misassemble or omit components.



## CLAIMS

1. An electrical conductivity connector comprising a conductive member (11) for connection to a metal enclosure (1) of multi-panel (3, 4) form, a plurality of leads (13), each lead being permanently secured at one end (13a) thereof to the conductive member, and each lead being provided at the opposite end (13b) thereof with respective attachment means (24') for electrically connecting the conductive member (11) to a respective panel (3, 4) or frame member of the enclosure, the attachment means (24) each carrying a respective captive fastener (23).
2. An electrical conductivity connector as claimed in claim 1 wherein the conductive member (11) is of planar form, with a fixing hole (12), enabling the conductive member to be fixed to the enclosure frame, or other suitable part of the structure, by use of a screw, or onto a stud.
3. An electrical conductivity connector as claimed in claim 1 or claim 2 wherein the respective first ends of the leads are secured at the periphery of the conductive member (11) which is provided with laterally spaced-apart pairs of integral clamping jaws (14).
4. An electrical conductivity connector as claimed in any one of the preceding claims wherein the captive fastener is a nut assembly (20).
5. An electrical conductivity connector as claimed in claim 4 wherein each captive nut assembly (20) comprises a nut (23) provided with an integral axial extension (29) of reduced lateral dimensions compared with the diameter of the nut, the axial extension extending through a hole (28) in a connector tag (24') and being captively connected at the free end thereof to a washer (25) positioned on the opposite side of the tag from the nut.

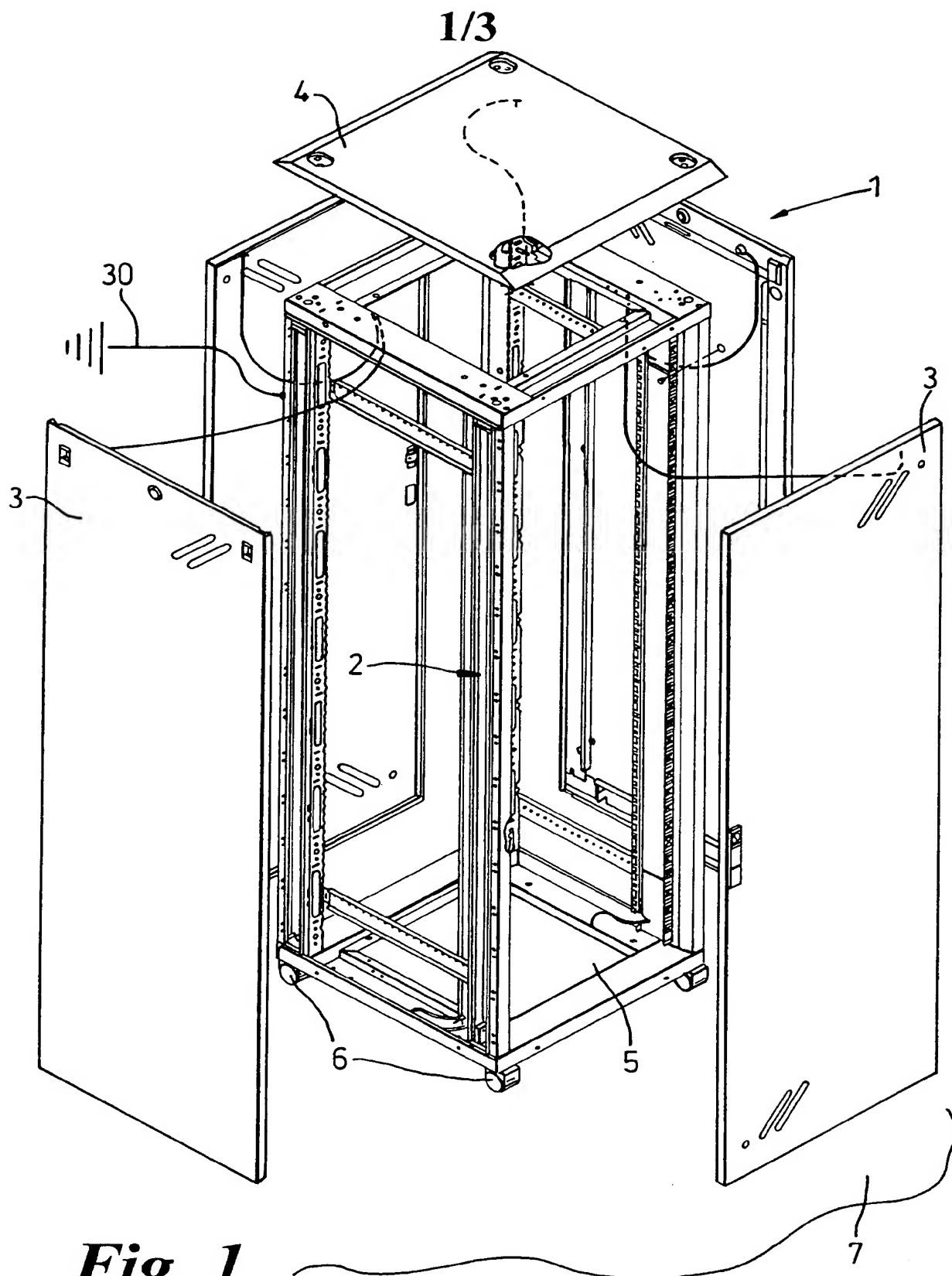
6. An electrical conductivity connector as claimed in claim 5 wherein the connection (31) between the free end of the axial extension (29) and the washer (25), and the dimensions of the axial extension, are arranged such that, on initial supply of the conductivity connector, the nut (23) is  
5 capable of being turned freely relative to the washer (25) and tag (24'), to reduce the tendency of the tag from being turned round when the nut is tightened onto the tag.
7. An electrical conductivity connector as claimed in claim 5 or claim 6 wherein the axial extension is an integral tubular extension (29) of the  
10 nut (23).
8. An electrical conductivity connector as claimed in any one of claims 5 to 7 wherein the free end of the axial extension is deformed radially outwards to define an annular retaining rib (31) that is received in a counterbore (32) to the bore (33) of the washer (25).
- 15 9. An electrical conductivity connector as claimed in claim 8 wherein the retaining rib (31) has been formed by a swaging operation which is controlled to permit rotation of the washer (25) relative to the axial extension (29) prior to fully tightening of the nut (23).
- 10 10. An electrical conductivity connector as claimed in any one of claims 5 to 9 wherein the connector tag (24') carries a pair of clamping jaws (24) by which said opposite end (13b) of the lead is secured to the tag.
11. An electrical conductivity connector as claimed in any one of claims 5 to 10 wherein the washer (25) is provided with gripping formations (26, 27) at least on the side that engages with the tag.

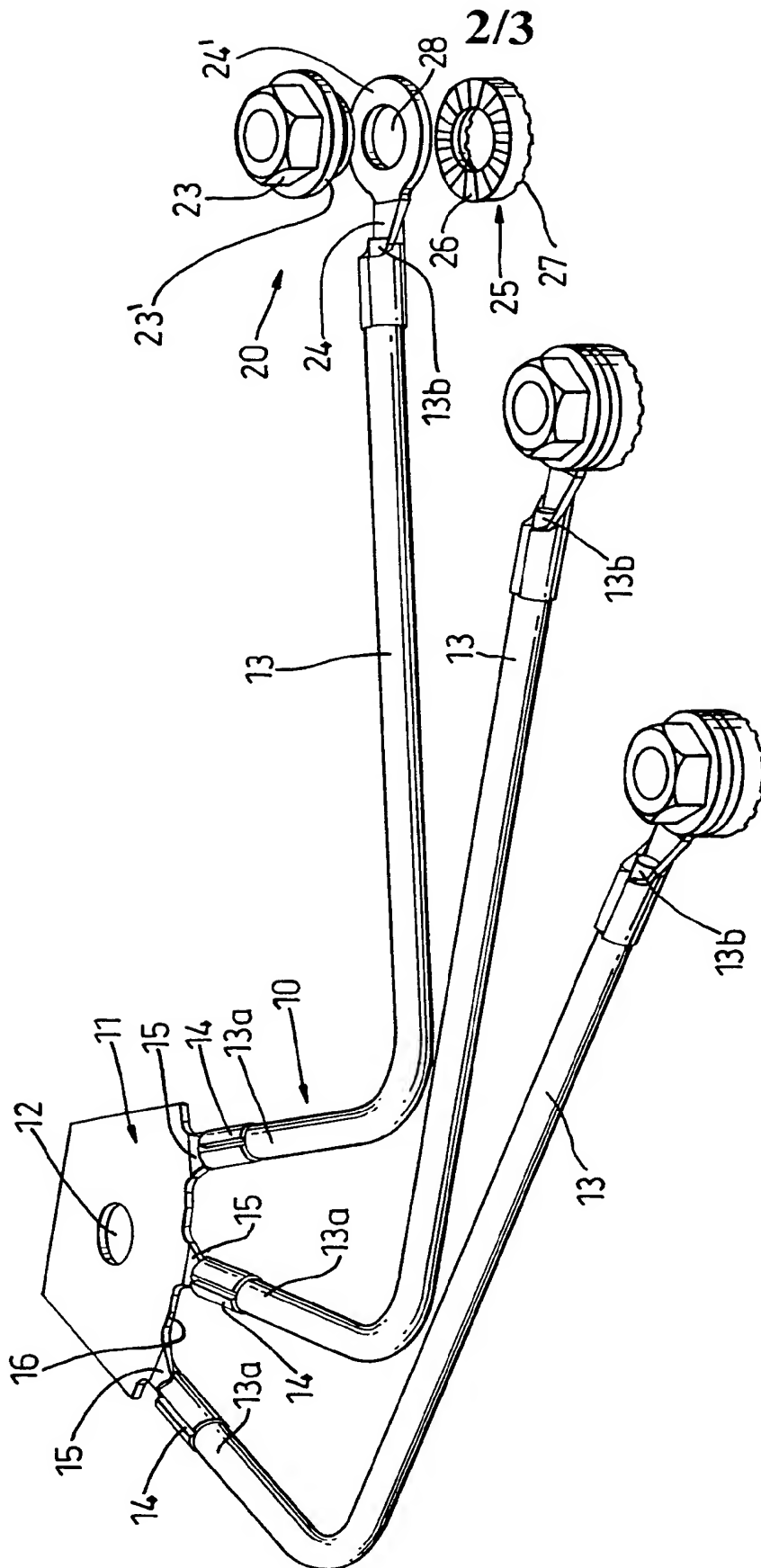
12. A combination of a metal enclosure and a plurality of electrical conductivity connectors as claimed in any one of the preceding claims.

13. A combination as claimed in claim 12 wherein the combination is of kit form whereby the enclosure comprises a flat pack.

5 14. A combination of a metal enclosure and a plurality of electrical conductivity connectors as claimed in claim 12 wherein the metal enclosure is in a pre-assembled state suitable for supply to an installer, but without connection of the fasteners that are to be secured to removable panels, said conductive members being pre-assembled to the  
10 enclosure, whereby the leads are available in the unit in the correct locations, ready for said other ends of the leads to be secured to the panels once the electrical installation has been performed.

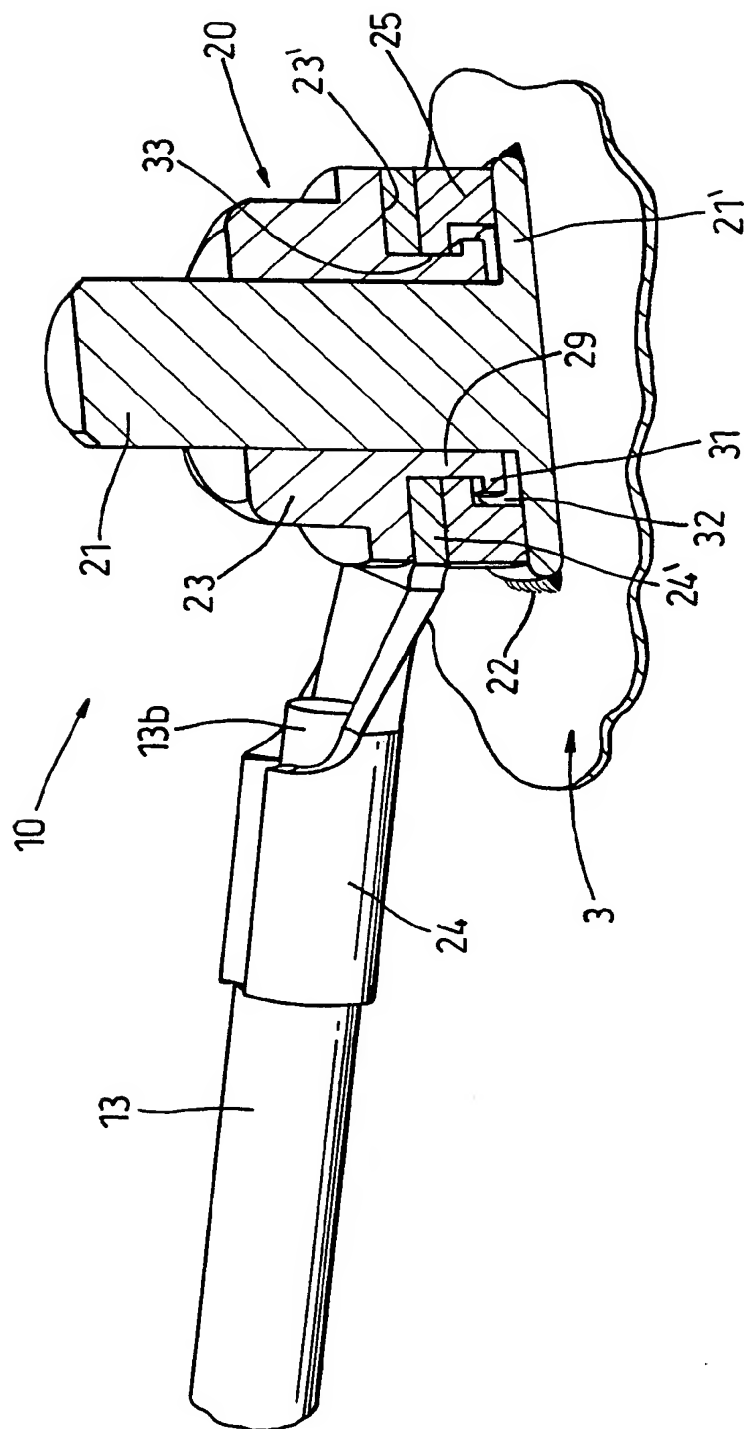
15 15. An electrical lead carrying a captive nut assembly at one end thereof, the nut assembly comprising a nut (23) provided with an integral axial extension (29) of reduced lateral dimensions compared with the diameter of the nut, the axial extension extending through a hole (28) in a connector tag (24) and being captively connected at the free end thereof to a washer (25) positioned on the opposite side of the tag from the nut.





*Fig. 2*

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*Fig. 3*